

Explainable and Scalable Planning with Probabilistic Temporal Logic Specifications

Completed Technology Project (2017 - 2020)



Project Introduction

Human spaceflight operations challenge currently available planning technology. They typically rely on a large number of integrated functions including mission planning, crew planning, solar array management, power and thermal management and system health monitoring. These functions serve under heterogenous uncertainties (stemming from anomalies and faults in equipment and intrinsic unknowns about the environment), time-varying requirements and multiple, possibly competing objectives. Co-work with the crew introduces unique difficulties as well. Humans' capabilities and limitations in these capabilities add to the uncertainties. Humans' preferences and need for compatibility between the humans and autonomous control protocols introduce unconventional constraints. The proposed effort introduces a paradigm shift in the planning-execution loop by addressing a number of these challenges. Our emphasis particularly on unambiguous, formal specifications and compilation of executable control software with provable guarantees and systematic sensitivity analysis diffuses the critical concern of reliability throughout the planning execution loop. The proposed algorithms will incorporate models with stochastic as well as nondeterministic uncertainties and rich specifications with temporal and logical relations as well as probabilistic and real-time modalities as needed. Integrated planning for the coupled functions introduces possibilities for system-level optimization, e.g., in performance, weights and overall cost. Finally, the proposed algorithmic and architectural advances will improve not only the scalability of the resulting synthesis algorithms but also their interpretability by and explainability to the crew and designers.

Anticipated Benefits

The ultimate goal is to produce a modeling tool for guiding the design and optimizing the operation of electrospray thrusters. Electrospray propulsion is an ideal technology for primary propulsion and attitude control of cubesats and larger smallsats. This project will produce the fundamental knowledge needed to fulfill its potential. Advanced micropropulsion could enable the use of smallsats in missions of high value to NASA such as spacecraft constellations, formation flying, insertion into high altitude orbits, interplanetary voyage, etc.



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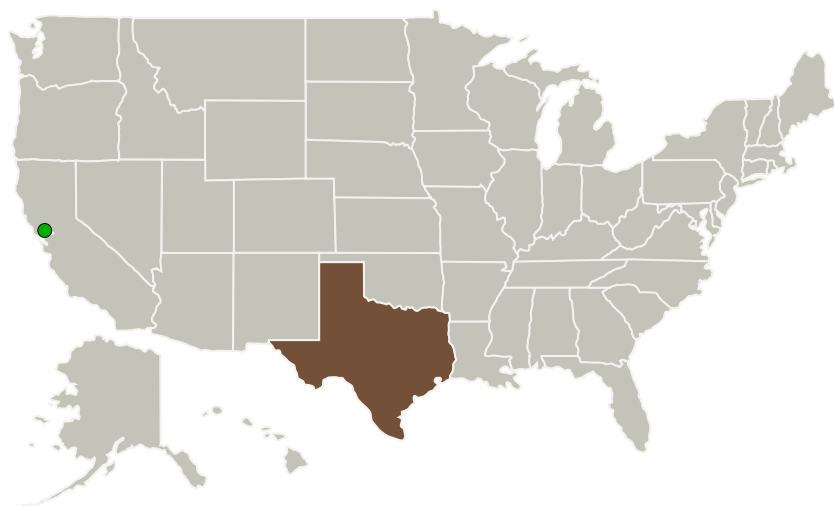
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Texas at Austin	Lead Organization	Academia	Austin, Texas
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations

Texas

Project Website:

<https://www.nasa.gov/strg#.VQb6T0jJzyE>

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

The University of Texas at Austin

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

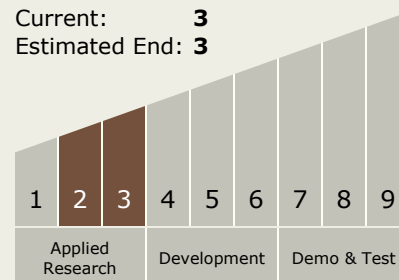
Hung D Nguyen

Principal Investigator:

Ufuk Topcu

Technology Maturity (TRL)

Start: 2
Current: 3
Estimated End: 3



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Technology Areas

Primary:

- TX10 Autonomous Systems
 - └ TX10.2 Reasoning and Acting
 - └ TX10.2.4 Execution and Control

Target Destinations

Earth, The Moon